2020

INSTRUCTION MANUAL

PLUG-IN

SPECTRUM ANALYZERS

MODEL

PSA 231

NR NELSON-ROSS ELECTRONICS INC.
5-05 BURNS AVE., HICKSVILLE, N. Y.

MODEL

PSA 231

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MODEL PSA 231

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SECTION I

CHARACTERISTICS

SCOPE

This Manual provides Operating Instructions, Theory of Operation, Technical Characteristics, Maintenance, and Trouble Shooting Procedures for Nelson-Ross Plug-In Low Frequency Spectrum Analyzers, Model:231.

This Analyzer is designed to provide coverage of the commonly used communications frequencies. Featuring extremely low levels of internally generated distortion, precision calibrated horizontal scan factors (cycles/cm), a 60db logarithmic display and a calibrated input attenuator, the analyzer is ideal for design, test and service of all types of narrow band communication systems and components.

The unit is designed so that it may be conveniently plugged into any Hewlett-Packard Type 140/141 Oscilloscope. By simply installing one of these plug-ins, the oscilloscope becomes a complete Spectrum Analyzer. In use, the Spectrum Analyzer provides both vertical and horizontal deflection signals for the oscilloscope. All voltages for Spectrum Analyzer operation are obtained automatically when the analyzer is plugged into the oscilloscope.

GENERAL INFORMATION

Before installing operating a NELSON-ROSS Plug-In Spectrum Analyzer it is important to have a clear understanding of the nature and interpretation of the spectral display it will provide. The convention use of an oscilloscope is to present a display of the amplitude/time characteristic of an electrical signal. In such a presentation the horizontal axis of the cathode-ray tube represents frequency and the vertical axis represents RMS amplitude. This is the type of display provided by NELSON-ROSS Plug-In Spectrum Analyzers.

The nature of the spectral display can be understood with the aid of the following illustrative examples:

1 - on an ideal spectrum analyzer, a signal containing energy at only one frequency will appear as a single vertical line on the display. This is illustrated in figure 1-1a.

2- multiple signals would then appear as multiple vertical lines, however close in frequency they may be. A carrier modulated by sidebands at plus and minus a small frequency increment would thus appear as in figure 1-1b.

3- since in real life nothing is ideal, a spectrum analyzer cannot present an infinitely narrow vertical line. Instead the signal is broadened into a pulse as in figure 1-1c. Similarly, multiple signals closer together than the width of the pulse will tend to blend as in figure 1-1d. This illustrates a basic spectrum analyzer parameter which must be considered; resolution. The smallest frequency difference between two equal amplitude signals which can be displayed is defined as the resolution of the analyzer. Two equal amplitude signals are considered resolved when they are far enough apart to cause a 3 db dip to appear between them. This is illustrated in figure 1-1e.

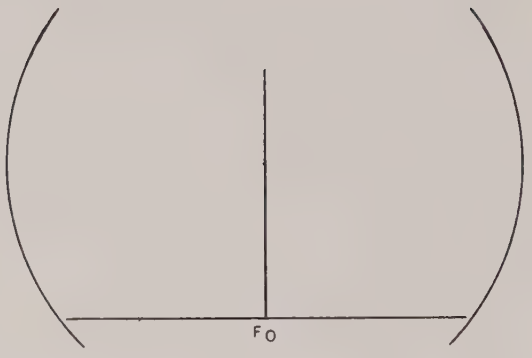
4- signals containing components closer together than the resolution of the analyzer generate a continuous spectrum, as illustrated in figure 1-1f.

There are three basic parameters to any spectrum analyzer display. They are;

Resolution - as defined in the previous paragraph

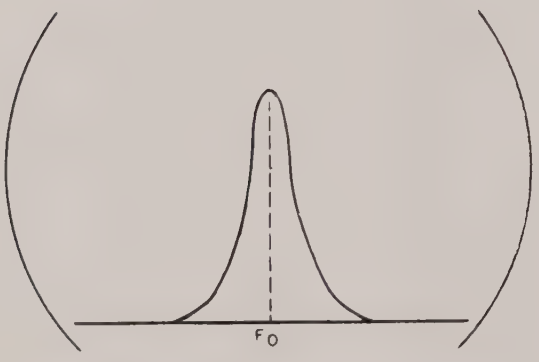
Dispersion - the width of the display (in frequency) on the cathode-ray tube.

Scan time - the amount of time taken to scan the dispersion mentioned above.

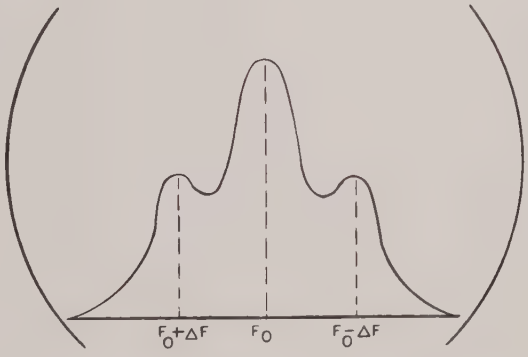


A— C W SIGNAL AS SEEN ON IDEAL SPECTRUM ANALYZER

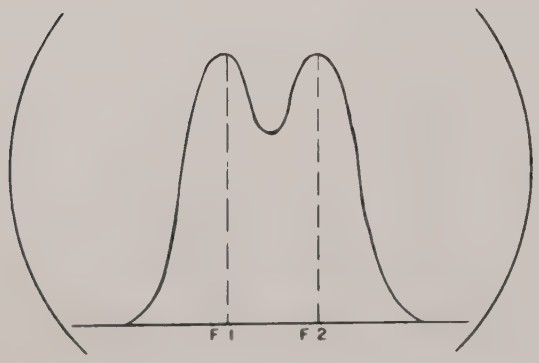
B— MODULATED SIGNAL ON IDEAL ANALYZER



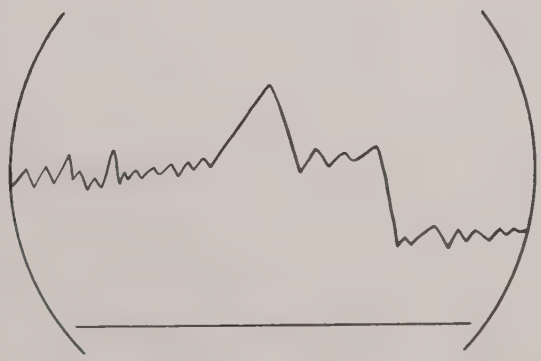
C— C W SIGNAL AS SEEN ON REAL ANALYZER



D — MODULATED SIGNAL ILLUSTRATING EFFECT OF RESOLUTION



E— TWO EQUAL SIGNALS JUST RESOLVED



F—CONTINUOUS SPECTRUM

FIGURE 1-1 SPECTRAL DISPLAY CHARACTERISTICS

Since the three parameters are interrelated it is important to understand the manner in which they effect one another. Scan time and dispersion may be combined to produce a factor called Sweep Rate (cycles per second per second) which may not be exceeded for any given resolution. Expressed mathamatically;

$$\frac{\text{Dispersion}}{\text{Scan time}} \qquad \text{(K) Resolution}$$

If this relationship is violated, either by reducing the scan time (increasing sweep speed) or by increasing the dispersion, the signal will smear and lose amplitude. This is an important point to remember - contrary to conventional oscilloscope operation - with a spectrum analyzer slower sweep speeds produce better displays. Since NESLON-ROSS Plug-In Spectrum Analyzers fit oscilloscopes with high sweep speed capabilities, the operator must remember to reduce the sweep speed sufficiently to obtain a good display. As a rule of thumb, the upper limit for any spectrum analyzer is 3-5 sweeps/second and many low frequency analyzers will require scan times in excess of 5 seconds.

The relationships mentioned above are of particular importance when making relative amplitude measurements. If the Scan Time, Dispersion or both are varied during a measurement - e.g. while searching for a harmonic or spurious signal - the sensitivity may vary. It is wise, therefore, to reduce the dispersion (or increase the scan time) until the signal amplitude is no longer attenuated by these effects before taking readings. As the dispersion is reduced (or the scan time increased) the amplitude of the component under observation will increase until a point is reached where further changes no longer have any effect. At this point a reading of amplitude may be taken.

TECHNICAL SPECIFICATIONS

SPECIFICATION	PSA 231
FREQUENCY RANGE	Same as PSA 230 with external L.O.; 600KC to 36MC with internal L. O. at specified sensitivities; to 108MC with harmonics at reduced sensitivity.
CENTER FREQUENCY	500KC when used with external L.O.
FINE TUNING	± 10KC by means of multiturn control
SCAN WIDTH (CYCLES/CM)	10KC, 2KC, 1KC, 500cps, 100cps, 50cps, 10cps
SCAN WIDTH ACCURACY	±10
RESOLUTION	Automatically programmed with scan width: 10KC-2KC 2KC - 2KC 1KC - 100CPS 500CPS - 100CPS 100CPS - 35 CPS 50 CPS - 10 CPS 10CPS - 10CPS
FREQUENCY TUNING RANGE	Four Bands: 0.6 to 1.7MC 1.7 to 5.5MC 5.5 to 16 MC 16 to 36 MC
CENTER FREQUENCY DIAL ACCURACY	± 5%
SENSITIVITY	Direct: -106dbm minimum Conversion: -100 dbm minimum with specified local oscillator power.
INPUT ATTENUATOR	51db in 1db steps

INPUT ATTENUATOR ACCURACY	0.1db per db
I.F. GAIN CONTROL	20db (nominal)
INPUT SIGNAL LEVEL	-100dbm (threshold) to -40dbm (full scale in log)
SIGNAL INPUT IMPEDANCE	50Ω BNC
DISPLAY	Linear or 60db log
DISPLAY LINEARITY	± 10%
DYNAMIC RANGE	Harmonic and I. M. Products at least 60 db below two equal full scale signals
DISPLAY FLATNESS	± 1db in all scan width ranges except ±2db in 10KC/CM Range.
VIDEO FILTER	50 Milliseconds, switch selectable
SWEEP SPEEDS	Automatically programmed with SCAN WIDTH switch, LOG-LIN switch and VIDEO FILTER switch Maximum: 8 Sweeps/Second (Nominal) Minimum: 15 Seconds/Sweep (Nominal)
FAST SWEEP	Push Button defeats sweep speed controls to provide fast sweep for convenience in turning
VERTICAL OUTPUT	0 to 1 volt from 10K maximum (Nominal) DC coupled - BNC Connector
HORIZONTAL OUTPUT	0 to 1 volt from 10K maximum (nominal) DC coupled-BNC connector

SECTION 2

OPERATING INSTRUCTIONS

INSPECTION AND INSTALLATION

It is important that a careful inspection be made of the unit immediately after it is unpacked. Look for obvious indications of any physical damage which may have been sustained during shipping. All tubes and crystals should be firmly seated in their respective sockets.
Insert the plug-in unit into any Hewlett-Packard model 140A oscilloscope. Turn the knurled lock knob (in the upper right corner of the analyzer) clockwise to secure the unit.

INITIAL ADJUSTMENTS

Certain initial adjustments must be performed when installing the plug-in unit for the first time. These initial adjustments must be made so that a true representation of control functions (presented in the next section) will be possible. Turn the oscilloscope power on, and allow a 10 minute warm-up period. Set the controls as follows:

INPUT ATTENUATOR	0 DB
I.F. GAIN	Fully CCW
SCAN WIDTH	1KC/CM
MANUAL-AUTO SCAN	Auto
60 DB LOG-LIN	Lin
VIDEO FILTER	Out
FINE TUNING	Centered
V POSITION	Centered
INTENSITY (on oscilloscope)	Centered
FOCUS (on oscilloscope)	Centered

Using the H POS and WIDTH screwdriver adjustments on the panel, set the trace to occupy the full 10 centimeter width on the CRT. Adjust the V POS

control to position the trace on the lowest 10 cm line on the graticule. Adjust the FOCUS and INTENSITY and ASTIGMATISM controls on the oscilloscope to provide a sharp trace of medium intensity. All initial adjustments having been accomplished, the instrument is ready for use.

NOTE ON DISPLAY AREA

The instrument is designed to present a display which occupies the central area of the CRT, 10 centimeters wide by 6 centimeters high. The two areas above and below the central region are not used. A full scale signal is defined as one which produced a 6 centimeter vertical deflection.

CONTROL FUNCTION AND OPERATION

In order to obtain the most efficient and accurate performance from any of the NELSON-ROSS Plug-In Spectrum Analyzer Units, it is essential that the function and marking of each of the controls be fully understood. Figure 2 - 1 contains a brief explanation of each control. The text portion of this section will present a further explanation of controls and the operational settings used during initial operation. The Spectrum Analyzer may be used in any application where the necessity exists to visually observe the frequency distribution of a signal. It is of course necessary that signal or/components of the signal being observed fall within the frequency range of the plug-in analyzer. With the instrument, it is possible to measure the relative amplitudes as well as the absolute values of each of the various components which make up a complex signal.

The Spectrum Analyzer is designed so that its basic operating characteristics may be adjusted to provide the parameters required for analysis of the desired signal. These parameters are adjusted thru the use of the following controls:

SCAN WIDTH (CPS/CM) - this switch selects any one of seven different horizontal scan widths for display on the CRT. Scan width is the horizontal

frequency scale of the instrument. For example, when the SCAN WIDTH selector switch is placed in the 1 KC/CM position, signals 1 KC apart will appear at 1 CM horizontal intervals on the display. Since the size of the display is ten centimeters, a total frequency band 10 KC wide will appear on the screen.

RESOLUTION AND SWEEP SPEED

It should be noted that there are no controls for resolution and sweep speed on the analyzer panel. In order to provide the utmose in convenience and accuracy, both of these functions have been automatically programmed with the various other functions of the analyzer. These functions are:

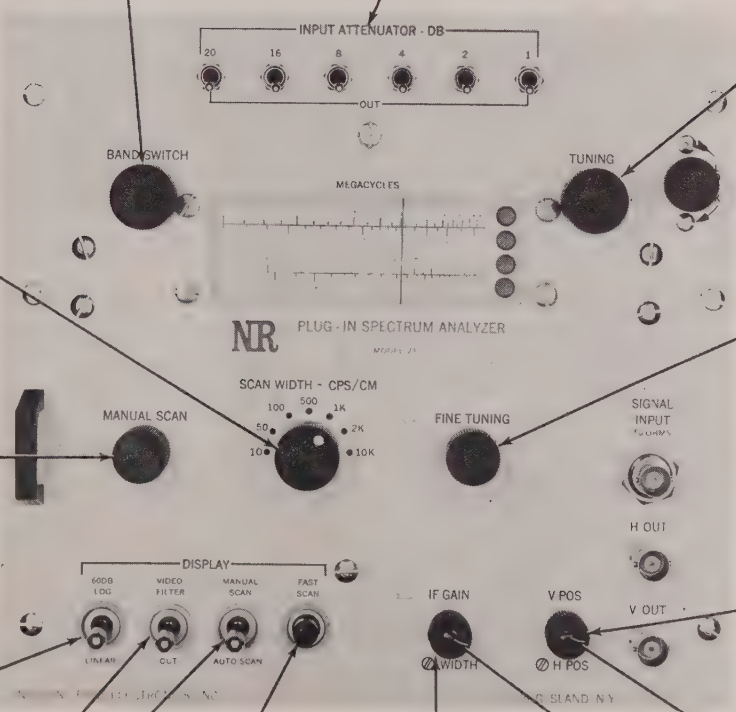
SCAN WIDTH - This control automatically programs both the resolution and sweep speed to provide a display of constant amplitude. The resolution is adjusted to provide the most suitable value for the horizontal sensitivity selected. (See Section 1 for an explanation of resolution). The sweep speed is also programmed to provide the fastest possible scan without amplitude sensitivity loss.

LOG-LIN: - The sweep speed is automatically decreased in the LOG position to compensate for increased dynamic range of the display. Resolution is not affected.

VIDEO FILTER: - The sweep speed is automatically decreased when the VIDEO FILTER is switched in, to maintain compatibility with the reduced video bandwidth. Resolution is not affected.

INPUT ATTENUATOR

This attenuator which consists of six individual steps, provides 51db of attenuation in 1db steps. It is a constant impedance attenuator, and must be properly matched in order to operate properly. The input impedance of the instrument is 50 ohms, and the characteristic impedance of the attenuator is also 50 ohms. Thus, the attenuator is properly terminated at all times. In order to obtain proper operation of the attenuator, the signal source impedance must also be 50 ohms.



SELECTS FREQUENCY BAND (SELECTED BAND INDICATED BY PILOT LIGHT ILLUMINATION)

PROVIDES 51DB OF ATTENUATION AT INPUT, REQUIRES 50 Ω MATCHED SOURCE

SETS CENTER FREQUENCY OF DISPLAY

SETS HORIZONTAL FREQUENCY SCALE (ALSO CONTROLS RESOLUTION AND SWEEP SPEED)

PROVIDES SMALL CENTER FREQUENCY ADJUSTMENT TO COMPENSATE FOR VARIATIONS IN SIGNAL INPUT FREQUENCY

PERMITS MANUAL SCAN OF CRT DISPLAY

POSITIONS DISPLAY VERTICALLY

PERMITS SELECTION OF EITHER 60 DB LOGARITHMIC OR LINEAR DISPLAY

POSITIONS DISPLAY HORIZONTALLY

INSERTS INTEGRATING TIME CONSTANT IN VIDEO

ADJUSTS WIDTH OF DISPLAY

SELECTS MANUAL SCAN MODE OF OPERATION

PROVIDES FAST SWEEP FOR COARSE TUNING

PROVIDES APPROXIMATELY 20 DB OF INSTRUMENT GAIN VARIATION

MODEL PSA 231
CONTROLS AND FUNCTIONS

FIGURE 2-2

While the instrument will operate with a considerable mismatch at the input, the attenuator accuracy and flatness will suffer. If there is any doubt as to the impedance of the source, and the attenuator is to be used, a co-axial pad of 6db or more should be inserted at the input to insure a good match. Since this attenuator is directly at the input, it may be used for relative amplitude measurements without the introduction of errors due to the analyzer.

DISPLAY CONTROLS

The LOG-LIN switch controls the type of vertical display produced by the oscilloscope. In the LIN position deflection on the oscilloscope screen will be directly proportional to the input signal amplitude, while in the LOG position the oscilloscope deflection will be proportional to the logarithm of the input signal. This provides a display calibrated directly in decibels. Since the instrument has a dynamic range of 60db, the LOG display provides a 60db characteristic. A signal 60db down from full scale produced a deflection of approximately one-half to one centimeter. In the first 40db of the display, each centimeter corresponds to 10db. A signal 50db down deflects the display $1\frac{1}{4}$ centimeters. It is thus possible to observe all components of a signal over a 60db range. Since the dynamic range of the display is greatly increased in LOG, the sweep speed of the analyzer is automatically reduced to provide a better display.

NOTE ON DISTORTION

In order to be certain that the instrument is not producing any spurious intermodulation products, the signal level at the input must be controlled so that:

A) In log display mode, the largest component of the signal does not exceed 6 cm or:

B) In LIN display mode, with the IF GAIN CCW and the INPUT ATTENUATOR at 51 db (maximum

attenuation) the largest component of the signal does not exceed full screen. The IF GAIN and INPUT ATTENUATOR may then be set anywhere in their ranges.

If these instructions are followed, the instrument will not contribute any IM (for other types of distortion products) greater than specified for the instrument.

The VIDEO FILTER inserts an integration time constant in the video amplifier of the instrument. This provides suppression of beat notes that occur when signals with close components are being observed. It is also useful in filtering out noise. Since the filter reduces the frequency response of the vertical amplifier, the sweep speed at the analyzer is automatically reduced when it is in operation.

The MANUAL-AUTO SCAN switch provides two methods of operation. In AUTO SCAN the instrument automatically scans the CRT display at an internally selected optimum sweep speed. In MANUAL, the CRT display is scanned by rotating the MANUAL SCAN knob on the panel. This permits point-by-point measurements to be made.

The FAST SWEEP button, when pressed, overcomes the internal sweep speed programmer, providing a fast sweep for tuning and searching. When this button is pressed the sweep speed will be greater than optimum, causing the display to ring. However, it is useful for locating signals, which may then be observed at programmed sweep speeds.

IF GAIN - This potentiometer provides a minimum of 20 db of gain variation in the IF system of the instrument.

FINE TUNING varies the center frequency of the instrument ±10KC to provide correction for small frequency changes in the input. When tuning the instrument by means of the TUNING control, the FINE

TUNING control should be centered, so that it may later be used to compensate in either direction.

BAND SELECTOR - This switch provides for the selection of four (4) frequency bands: .6 to 1.7 MHz, 1.7 to 5.5 MHz, 5.5 to 16 MHz, and 16 MHz to 36 MHz. Four pilot lamps are provided on the tuning dial. Only one lamp will light indicating the selection of that band.

TUNING (COARSE) This control provides for center frequency tuning and is used with the tuning scale which is calibrated directly to the input center frequency. The control incorporates a mechanical vernier which permits accurate setting of the tuning scale. Actually, this control tunes the local oscillator directly and serves to control the center frequency accordingly. The first IF frequency of the analyzer is 500 KHz. The instrument input circuit is a mixer, which is designed to add and subtract the input and local oscillator signals. Combinations of signals producing a difference of 500 KHz will result in a display on the CRT. The signal, when applied to the INPUT connector will be displayed on the CRT screen without distortion.

NOTE ON IMAGES, HARMONIC MIXING, ETC.

For each input frequency, there are two primary local oscillator frequencies that will produce a display: 500KHz above and 500KHz below the input signal frequency. Either one may be utilized, with the same results. Other, secondary, frequencies may also produce a display. Any oscillator input which has a harmonic differing from the input by ±500KHz will produce a display. All of these displays will be true spectra of the input, differing from one another only by the instrument gain and sensitivity, and the

"sense" of the horizontal scan.

The sense of the horizontal scan depends upon the mixing process selected. The CRT spot always travels from left to right on the display. A 500 KHz signal at the input will appear at the center of the screen, as will any signal producing 500 KHz in combination with the local oscillator. Frequencies (600 KHz 36 MHz) lower than the center frequency will appear to the right of center and frequencies higher than the center frequency to the left of the center of the display (with a signal input of 500 KHz there will be an inversion of the display, with higher frequencies appearing on the right and lower frequencies on the left). It can be seen from the above that many displays will appear at different points on the center frequency tuning dial. The desired display is called the signal display. The second primary display is commonly called the Image, while all others are classified as spurious responses. These usually occur as signal and image pairs in the same manner as the primary displays. There are occasions when it may be desirable to utilize one of the spurious responses to generate the display. This usually occurs when a signal much higher than the internal local oscillator is to be observed. The local oscillator is tuned to a subharmonic ($\frac{1}{2}$, 1/3, $\frac{1}{4}$, etc.) of the actual oscillator frequency required.

The mixer generates the required harmonic , resulting in a display of the signal as required. This is commonly called harmonic mixing. It should be born in mind, when using this technique, that a loss of sensitivity always accompanies harmonic mixing. The resulting spectrum, however, will be correct.

The question arises as to how the operator can determine whether he is looking at the signal or the image frequency on the display. This knowledge is often important, so that "upper" and "lower" sidebands can be distinguished, or if the exact frequency of the signal is unknown. There are a set of general rules on how to determine the exact relationship, of signal and local oscillator:

a) to determine whether the oscillator is above the signal or below:

Center the signal on the display, and then increase the oscillator frequency (tuning control) slightly. If the signal moves to the right, the oscillator is above, if it moves to the left, the oscillator is below the signal.

b) to determine whether you are looking at a harmonic of the signal:

Tune to integral subharmonic input frequencies and look for the same display. They will usually appear with much greater amplitude.

c) to determine whether you are using the oscillator directly or on a harmonic:

Increase the oscillator frequency (tuning control)

by intergral factors and look for the same display. The highest oscillator frequency which will produce a display is the one causing the primary displays.

SECTION III

APPLICATIONS

The NELSON-ROSS series of Plug-In Spectrum Analyzers are capable of performing in a multiplicity of applications. The following paragraphs and illustrations are but a few examples of possible instrument applications. Since the CRT photographs were taken with models other than those described in this manual, it is possible that the direction of the sweep may be reversed, producing a presentation opposite to that of the instrument covered in this manual.

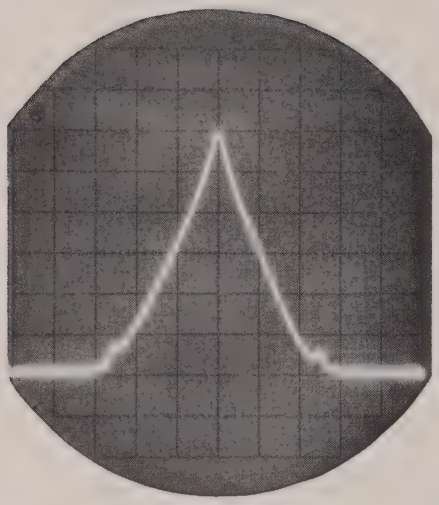
DISTORTION ANALYSIS- The percentage of distortion products of both amplifiers and oscillators may be determined by using an instrument operating within the desired range. Examination of the input signal is first made. Quality and harmonic content are observed. The output of the unit under test is then observed. Performance is determined by subtracting the input harmonic content from the output harmonic content.

INTERMODULATION DISTORTION PERCENTAGE - Measurement is made by using a two-tone oscillator to drive the unit under test. In addition it's possible to use two oscillators which are fed into a resistive mixer coupled to the input of the unit. The sum and difference signals in the output are then measured in relation to the fundamental outputs.

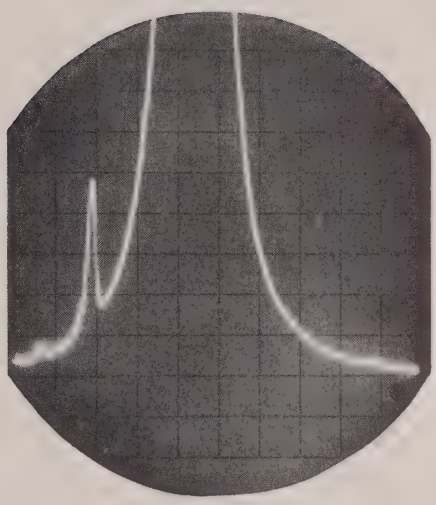
TYPICAL DISPLAYS- Figures 3-1A through 3 -1D illustrate oscilloscope representation which are obtained in typical Spectrum Analyzer applications. A brief technical description accompanies each figure.

3 - 1A This photograph was taken to demonstrate the dynamic range and resolution of the instrument. The display is LOG at 50 cps/cm (10 cps resolution) SCAN WIDTH. A cw signal was supplied at

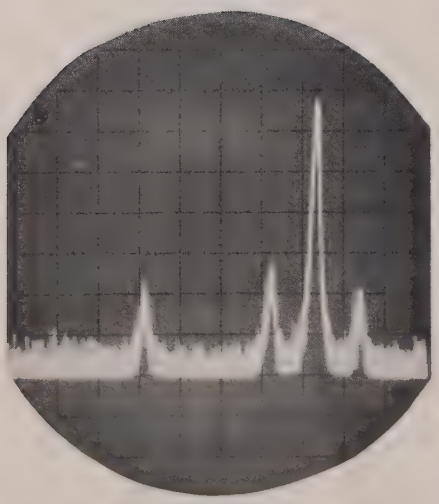
(10 cps resolution) SCAN WIDTH. A sweep signal was supplied at



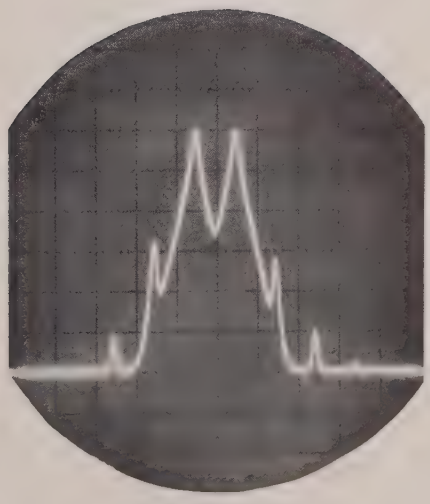
3-1A



3-1B



3-1C



3-1D

TYPICAL CRT DISPLAYS
(see text)

FIGURE 3-1

5 mc, with modulation producing two sidebands at ±120 cps, 60 db down. Note the freedom from spurious responses and hum sidebands.

3 - 1B Analysis of a carrier generator with 120 cycle hum component 46 db down. The display is LIN, at 50 cps/cm (10 cps resolution) SCAN WIDTH. Smaller hum components at -60 db + 180 cps and -240 cps are also visible.

3 - 1C This is a 7.5 mc single sideband transmission taken directly off the air at approximately -85 dbm peak sideband power. A 2200 cps tone was being transmitted, 30% modulated at 520 cps. Note the carrier at the left. Carrier suppression is apparently only 10db. However, it was determined that the 2200 cps tone was being transmitted at -20 db relative to rated peak sideband power, so the actual carrier suppression is 30 db.

3 - 1D This display results from two-tone IM test being made on a linear power amplifier. The signal was obtained by loosely coupling to the dummy load. The input was two equal tones 1KC apart. IM products are clearly visible at -30 db and -55 db.

SECTION IV

CIRCUIT DESCRIPTION

GENERAL

The circuit description presented in this section applies to NELSON-ROSS Plug-In Spectrum Analyzer, Model PSA 231.

BLOCK DIAGRAM DESCRIPTION

Figure 4 - 1 is a block diagram representation of the circuitry in the NELSON-ROSS Plug-In Spectrum Analyzer.

The input signal first passes through the input attenuator where the desired level is adjusted. The attenuated input signal is then routed through the balanced mixer. The input signal is mixed with the local oscillator in the balanced mixer. Oscillator spurious products are suppressed, while the sum and the difference frequency signals are enhanced. The output of the mixer is amplified in the low-noise, wide band 500KC IF amplifier, and fed via the IF GAIN control to the second mixer and oscillator, where it is heterodyned with the swept local oscillator (550 to 650 KC). The resultant difference signal then passes through the 100KC crystal filter.

The frequency response of this filter is varied with the SCAN WIDTH control in order to provide the required degree of signal resolution on the screen of the oscilloscope. The signal output from the filter drives the IF amplifier. The IF amplifier is tuned to the 100KC difference frequency of the mixer output. The output of the IF amplifier is detected and routed two ways.

One routing passes to the vertical amplifier. The other routing provides a feedback signal which is used to generate a log function. When the video filter is in the LIN position, this feedback signal is not utilized.

The sawtooth output of the internal sweep generator is utilized to drive both a reactance tube and the H amplifier in the oscilloscope. The sweep speed is automatically varied by the SCAN WIDTH switch. The reactance

tube sweeps the local oscillator in synchronism with the oscilloscope trace. Reactance tube drive is furnished through the Scan control circuits, operated by the SCAN WIDTH switch.

DETAILED CIRCUIT DESCRIPTION

INPUT ATTENUATOR

The input attenuator, shown on B1000-448, consists of 6 toggle-switch operated pi-section attenuators. With the switch in the OUT position, the attenuator is removed from the circuit. In the IN position a 50Ω pi-section having the required loss is inserted. In this manner, the circuit impedance is held constant.

PHASE INVERTER (MIXER DRIVER)

The phase inverter converts the single-ended oscillator input into a push-pull signal for the balanced mixer. It consists of a pentode amplifier with equal plate and cathode loads (furnished by adjustment of the MIXER BAL potentiometer R6).

BALANCED MIXER

The balanced mixer consists of diodes CR1 and CR2, coupled to the IF amplifier by means of transformer L1. The push-pull oscillator input cancels in the output, while the signal and the mixing products appear on the primary of L1. The secondary of L1 provides an impedance step-up to match the grid of IF amplifier V2.

500 KC IF AMPLIFIER

This amplifier, consisting of tubes V2 and V3, determines the noise figure of the instrument (in conjunction with the mixer) and provides sufficient gain to overcome the noise of the second mixer. It is a tuned doublet, with 3 db points ± 50KC from the center frequency of 500KC. The gain of V2 is controlled by internal adjustment potentiometers R57 (2KC GAIN), R58 (100 cps GAIN) and R 59 (35 cps GAIN) via the SCAN WIDTH switch to provide constant instrument gain despite variations of the crystal filter loss with resolution changes.

SECOND MIXER AND OSCILLATOR

The second mixer is a pentagrid converter, driven from a triode oscillator. Dual triode V7 serves as both a Hartley oscillator and a reactance tube. Coil Z4

provides resonant tank circuit inductance. The reactance circuit is conventional in design. Capacitor C41 provides only a portion of the resonant capacitance of the tank circuit. Additional capacitance is inserted across the coil by the grid plate capacitance of the reactance tube section of V7.

This capacitance is multiplied by the gain of the stage. The capacity seen by the oscillator tank is therefore proportional to the GM of the tube. When the plate currect on the tube is varied (by changes in the sawtooth drive present on the grid) the GM of the tube changes. As a result of this change in GM, the local oscillator frequency changes. Adjustment of RT ADJUST potentiometer R49 will determine the oscillator sweep frequency range with the full sawtooth input.

CRYSTAL FILTER

V5 and V6 are utilized to drive the two sections of the crystal filter network. Resolution is determined by the combined bandwidth of the two crystal filter sections. Bandwidth of each filter section is determined by shunting the output of each section with a resistance. By changing the value of resistance the effective "Q" is changed. As a result, the filter bandwidth around the IF frequency is also varied. The bandwidth determines the resolution of the plug-in unit. The SCAN WIDTH switch S1A and S1E simultaneously vary the "Q" of both sections. Capacity across each of the crystal holders is neutralized by adjustment of trimmer capacitors C26 and C29.

IF AMPLIFIER

The IF amplifier is composed of two double tuned stages consisting of V8 and V9. The majority of the plug-in unit gain is provided by this circuit. With the exception of the log feedback the amplifier circuitry is quite conventional. The output of V9 is a DC voltage which appears only when an IF signal is present. The output of V9 is a detected by diode CR 4. The detected signal is then fed to the oscilloscope vertical amplifier through an integrating network consisting of resistor R63, the video filter switch, and capacitors C44, and C46.

LOG CIRCUITRY

Log scale generation is accomplished by utilization of a feedback signal to control the gain of V8. The IF signal from the output of V9 is detected and the resultant voltage is fed back to the grid of V8 as a bias voltage. V8 has a cut-off characteristic especially applicable to this circuit. As the input increases, the detected bias also increases. The result is a decrease in the gain of the stage. The pentode characterisitics of V8 determine the logarithmic pattern of the oscilloscope display. The decibel range is controlled by varying the setting of the diode output divider R69 (DB RANGE). Any change in this screen voltage has a direct effect on the operating point and the slope characteristics of the tube. Adjustment of potentiometer R61 (DB SHAPE) provides the desired log shape.

SWEEP GENERATOR

Tubes V11 and V12 function as a free running sawtooth generator. The negative feedback between plate and grid of V11 (via cathode follower V12 and RC network; C49 and R87 through R93) determines the sweep time, while the positive feedback between the plate and screen of V11 generates the retrace. The scan time is a function of the RC time constant and the applied voltage. These parameters are automatically controlled by the SCAN WIDTH switch, the VIDEO FILTER switch and the 60 db LOG-LINEAR switch to provide optimum scan time for all control settings.

DEFLECTION AMPLIFIERS

Tubes V10 and V13 function as VERTICAL and HORIZONTAL deflection amplifiers, respectively. Single-ended signals present on one grid (pin 2) are converted into push-pull signals at the plates. The DC voltage at the plates is varied by controls R83 and R81 to provide positioning of the CRT trace.

INTERNAL LOCAL OSCILLATOR

An internal local oscillator provides the required minimum signal output at J206. V201 acts as both the Hartley oscillator and the isolating cathod follower. The bandswitch selects any one of four resonant tank circuits,

providing frequencies from 1.1 to 36.5 megacycles. The low output impedance is provided by the cathode follower.

POWER AND BIAS CIRCUITRY

All operating voltages required for plug-in unit operation are secured from the oscilloscopes internal power supplied. In order to insure a high degree of regulation over a wide range of operating condigions, all unused supplies (within the oscilloscope) are loaded to their minimum requirements.

SECTION V

MAINTENANCE

INTRODUCTION

In the design and construction of the NELSON-ROSS Plug-In Spectrum Analyzers, much emphasis has been placed upon high reliability and minimum down-time. However, any piece of electronic equipment will require a certain amount of maintenance thru normal usage. With this in mind, the following maintenance information is provided int his section. In the event of the occurance of a malfunction in the Spectrum Analyzer system, it is recommended that the trouble be corrected by following four general steps:

1. Confirmation that a malfunction actually does exist
2. Isolation of the trouble to either the Plug-In Spectrum Analyzer unit or the oscilloscope main frame
3. Trouble-shooting the plug-in unit to determine the exact source of trouble
4. Repair the malfunction

CONFIRMATION

It has been found thru experience that many indications which are presumed to be caused by a malfunction in the equipment actually result from incorrect control settings. All controls should be checked for correct settings. Once determination is made that anactual equipment malfunction does exist, it must be ascertained whether it is located in the plug-in unit or the oscilloscope frame.

ISOLATION

Isolation of the trouble to either the oscilloscope or the plug-in unit may be accomplished by either of two possible methods. In the first and simplest method, the plug-in unit is removed and replaced with a spare plug-in. The second method requires verification of input signals, supply voltages, and analysis of the screen display.

CAUTION

Before plugging in the spare unit, it is essential that a careful inspection be made of the suspected original

unit, for evidence of charred components or burned wiring. Any indications of such damage could be the result of excessive oscilloscope supply voltages. In such cases it is absolutely necessary to make complete voltage checks prior to installing a spare. If this precaution is not taken, the spare unit may become damaged.

If, after a spare unit (known to be functioning properly) is substituted the system does not work properly, the fault exists in the oscilloscope. Refer to the oscilloscope instruction manual for correct maintenance procedures. In a case where a spare unit is not available for substitution further testing must be performed. A plug-in extension cable (available from the oscilloscope manufacturer) may be used to facilitate the required testing, or the top and bottom covers may be removed from the oscilloscope, and the unit stood on its side. First, check all voltages supplied by the oscilloscope to the plug-in unit. If the voltages measure incorrectly, remove the plug-in Spectrum Analyzer and recheck the voltages. At this point, if the voltages check correctly with the Spectrum Analyzer removed, the trouble may be assumed to be in the plug-in unit. If these conditions are met, the Spectrum Analyzer bay be considered to be malfunctioning.

The voltages indicated on the schematic diagram and the tube chart are nominal, with the exception of the supply voltages which are of close tolerance. The other, "Nominal" voltages may vary considerably in each instrument.

TROUBLE SHOOTING THE SPECTRUM ANALYZER

When it has been definitely established that the malfunction exists in the Spectrum Analyzer plug-in unit, the following trouble shooting procedures are recommended. Much time and effort will be conserved by first performing a very thorough visual inspection of the plug-in unit. Carefully scurtinize the unit for evidence of burned or borken wires, defective switches, overheated or discolored components, and loose or improperly seated tubes and crystals. In the event that a burned or discolored component is discovered (through visual inspection) it is essential

that the direct cause of the trouble be located, and corrected before replacing the component.

One very common source of trouble may be attributed to faulty vacuum tubes. If a visual check fails to reveal the cause of the trouble, it is recommended that all tubes be checked by the substitution method. Tube checks made by the tube tester method are not to be relied upon because of the wide tube operating parameters. Tubes which are found to be operating correctly should be returned to their original sockets. This will eliminate a great deal of necessary recalibration, usually resulting from variable tube characteristics.

If, after visual examination and tube substitution, the trouble still is not located, the spectrum analyzer circuitry should be checked by making careful voltage and resistance measurements at the points indicated on the schematic diagram and the tube voltage chart.

SECTION VI

ALIGNMENT PROCEDURES

GENERAL

This section provides the complete procedures for aligning the NELSON-Ross Plug-In Spectrum Analyzer 231. These instructions, when followed in the proper sequence, also furnish a method of separating any troubles which may occur. Therefore, this procedure can be used when trouble shooting the Spectrum Analyzer.'

LIST OF TEST EQUIPMETN REQUIRED

The following equipment (or equivalent) is required to properly align Model 231:

1. Oscilloscope H.P. 140A; upper and lower covers and plug-in partition removed
2. Oscilloscope H.P. 140A; with 1400A or 1401A vertical plug-in and 1420A time base plug-in.
3. Signal Generator, HP 606A
4. Audio Oscillator HP200AB
5. VOM Simpson 260
6. Assorted cables, clip leads and connectors, as required.

ALIGNMENT PROCEDURE -MAIN CHASSIS

1. Insert the analyzer in the HP 140/141A frame (item 1) and lock. Connect all instruments to the power line and warm-up for ten minutes.

2. For convenience, stand oscilloscope containing analyzer on its side, CRT end down. Both sides of analyzer may now be reached for adjustments.

3. Set analyzer and scope controls as follows:

(NOTE: These control settings are to be used for all tests unless otherwise stated)

IF GAIN: CCW

SCAN: Auto

Model 231:

The following equipment (or equivalent) is required to properly align and test the Model 231 unless otherwise stated.

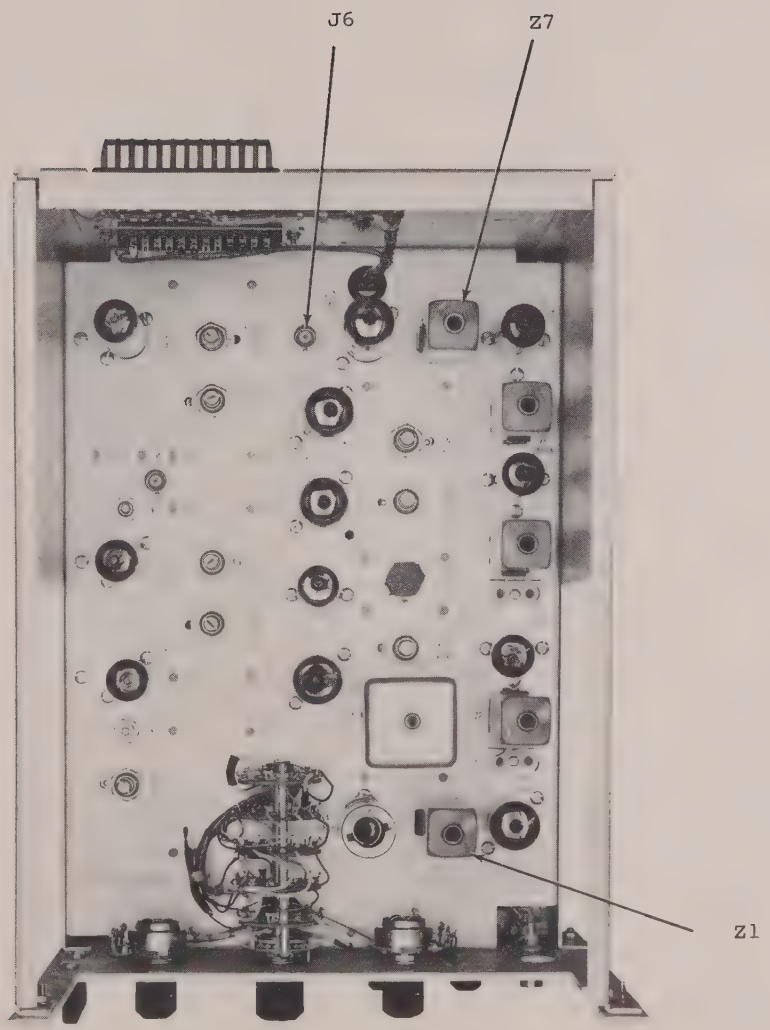
1. Oscilloscope H.P. 140A/140A/141A with H.P. 1400A or 1401A vertical plug-in partition removed
2. Oscilloscope H.P. 140A with 1400A or 1401A vertical plug-in partition removed
3. Signal Generator H.P. 606A
4. Audio Oscillator H.P. 200AB
5. VOM (Simpson 260 or equivalent)
6. Assorted cables, clip leads and connectors, as required.

ALIGNMENT PROCEDURE - MAIN CHASSIS

GENERAL: The procedures for aligning the NELSCO Spectrum Analyzer are provided in two parts. Part I covers the alignment of the main chassis and Part II covers the alignment of the plug-in units. Before attempting to align the instrument, it is recommended that the operator become familiar with the operation of the instrument by reading the Operating Instructions.

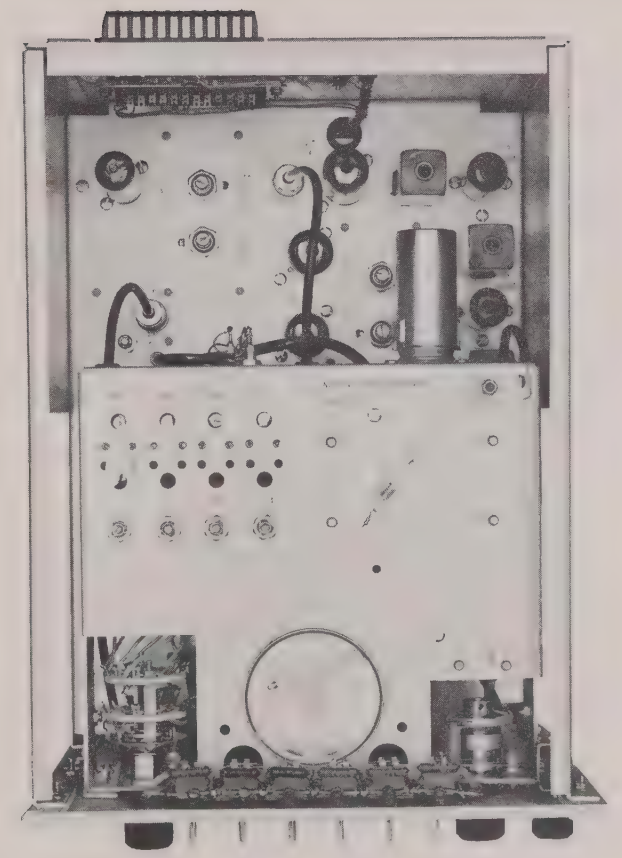
1. Inspect the analyzer using the H.P. 140A/141A mainframe (Item 1) and look for obvious defects and broken parts. Connect all instruments to the power line and warm-up for ten minutes.
2. For convenience, stand oscilloscope containing analyzer on its side. Check CRT for proper focus, astigmatism and geometry. Set the oscilloscope controls as follows:

   SCAN: Auto
   TIME/CM: .2 MS
   TRIGGER: INT
   SWEEP: Cont.
   VOLTS/CM: .5
   MODE: A
   A: AC
   A: Amplitude Calibrated
   A: Variable Cal. Detent
   A: Position: Mid-range
   A: Polarity: +
   A: Trigger: Auto
   A: Trigger Level: Mid-range
   A: Trigger Slope: +
   A: Trigger Source: Int.
   A: Trigger Coupling: AC
   A: Trigger Mode: Auto
   A: Trigger Position: Mid-range
   A: Trigger Polarity: +



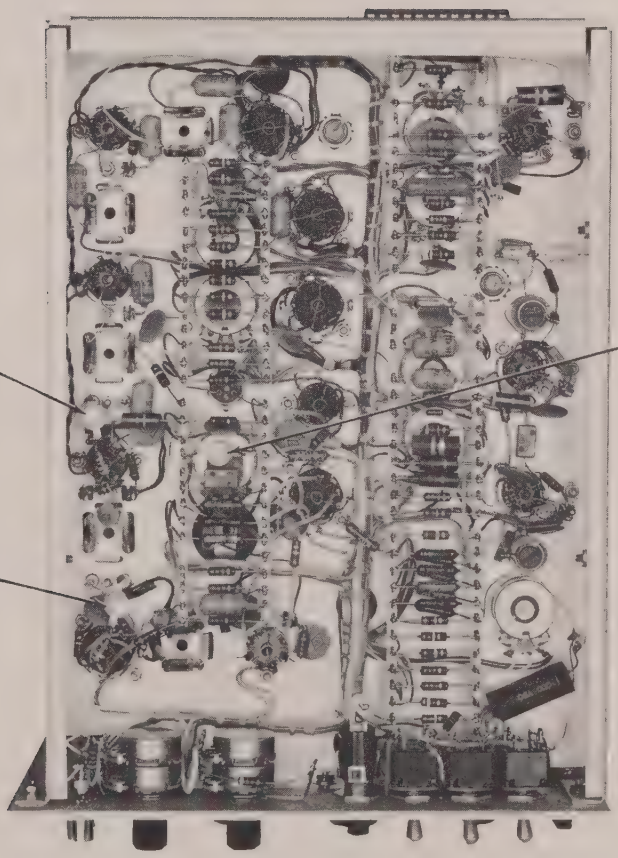
MODELS PSA 230 AND PSA 231
TOP CHASSIS
ALIGNMENT CONTROLS

FIGURE 6-1



MODEL PSA 231
INTERNAL LOCAL OSCILLATOR ADJUSTMENT

FIGURE 6-3



MODELS PSA 230 AND PSA 231
BOTTOM CHASSIS
ALIGNMENT CONTROLS

FIGURE 6-2

DISPLAY: Linear

VIDEO FILTER: Out

V POS: Centered

WIDTH: Centered

H POS: Centered

FINE TUNING: Centered

INPUT ATTENUATOR: Out

SCAN WIDTH-CPS/CM: 10K

BAND SWITCH: CW

TUNING: Centered

MANUAL SCAN: Centered

FOCUS: Centered

INTENSITY: Centered

4. Adjust the WIDTH and H POS front panel screwdriver adjustments to obtain a 10cm wide centered trace.

5. Adjust the V POS Front panel control to place the trace on the lowest 10cm horizontal line on the graticule.

6. SAWTOOTH ADJUSTMENT (Dispersion Balance)

Connect the oscilloscope (item 2) to the H OUT jack of the analyzer and observe a 1 volt peak-to-peak (nominal) sawtooth. With the oscilloscope D.C. coupled, carefully adjust the DISPERSION BAL (R96) potentiometer-top chassis-to obtain equal positive and negative excursions around ground. Disconnect the oscilloscope.

7. Connect the signal generator(item 3) to the SIGNAL INPUT Connector on the panel. Be sure to use a 50Ω coaxial BNC to BNC cable. Set the generator to 500 kHz at about 10 millivolts output. Connect the oscilloscope (item 2) to the V OUT jack of the analyzer and observe a 2 volts peak-to-peak output (nominal) when the signal amplitude is full scale (6cm) deflection. The IF GAIN control must be adjusted to provide this deflection.

8. DISPERSION SET ALIGNMENT

Set the controls on analyzer as follows:

INPUT ATTENUATOR: Out

BAND SWITCH Band 3

BAND SWITCH

Band 3

TUNING	Approximately band center
FINE TUNING:	Centered
FILTER:	Out
IF GAIN:	Centered
DISPLAY	Linear
SCAN WIDTH -CPS/CM:	1K

a) Apply a 500 kHz signal from the signal generator (item 3) to input of analyzer. Using the Center Freq. Adjust (C41), center the 500kHz signal on the screen.

b) With 500 kHz signal centered, apply 5kHz, 20% modulation from audio oscillator (item 4) to the signal generator (item 3) (SCAN WIDTH switch must be in 1kHz/cm pos). Using the RT ADJ. potentiometer (R49) adjust the 5kHz sideband modulation for full screen (10 cm wide) deflection. It may be necessary to re-center the signal on the screen. This is accomplished by adjustment of the Center Frequency Adj. Trimmer (C41). Since there is interaction between R49 and C41 small adjustments are suggested on each until the correct display is achieved (See Figure 6 - 4).

c) After this adjustment, all SCAN WIDTH positions are set. Check other positions for 10% accuracy in a similar manner.

d) Turn Modulation OFF.

9. CRYSTAL FILTER ALIGNMENT

a) With a 500kHz signal applied to input and SCAN WIDTH switch at 1K remove crystal Y1 from its socket (NOTE: adjust signal amplitude to keep PEAK of signal visible). Tune single-slug tuner z2 for the broadest pass band. DO NOT tune for maximum but rather for a minimum point at which the signal is widest and shape of the pass band is smooth and even. Replace Y1.

b) Remove Y2 from its socket. Tune Z3 (bottom slug only) transformer for broadest band pass (DO NOT tune for maximum amplitude). Replace Y2.

c) Tune Z2 and Z3 (bottom slug) alternately for broadest band pass.

d) Switch LOG-LINEAR switch to 60db LOG. Increase signal to full scale (this expands the skirts of the signal and will give a clearer picture of the skirt leakage, which shows up as a raised baseline on either side of the signal). If skirt leakage is visible adjust C26 and C29 to minimize leakage and obtain the best, symmetrical band pass characteristics.

e) Switch LOG-LINEAR switch to LINEAR and retune Z2 and Z3 for maximum flatness.

10. RESOLUTION CALIBRATION

Analyzers are shipped from the factory with correct resolution components already selected and mounted (R32, R33, R34, R42, R43, R44). These resistors do not normally require any service. If the crystals are replaced for some reason, it may be necessary to replace these resistors. The proper values of the resistors are listed with replacement crystals. These values must be used to assure complete compliance with published technical specifications.

11. I.F. ALIGNMENT

a) With the 500kHz signal counter to the INPUT, set the controls as follows:

SCAN WIDTH-CPS/CM	1K
INPUT ATTENUATOR:	Out
DISPLAY:	Linear

and IF GAIN required to provide a full screen signal.

Tune Z1, Z6, and Z7 top and bottom slugs for maximum signal output. Keep level of the signal visible using the IF GAIN control.

12. RESOLUTION GAIN ADJUSTMENTS

a) Set SCAN WIDTH Switch to 10cps/cm. Adjust 500kHz signal for full scale deflection 6cm.

b) Using this signal amplitude as a reference, switch SCAN WIDTH-CPS/CM to 10. Using R59, adjust Signal amplitude for

Full Scale Deflection (6cm).

d) Turn SCAN WIDTH -CPS/CM to 2K. Using R57, adjust the signal for Full Scale Deflection (6cm). In all SCAN WIDTH positions, the signal should have the same amplitude plus or minus lcm of amplitude.

13. PRELIMINARY SENSITIVITY CHECK

a) Turn SCAN WIDTH-CPS/CM switch to 10K. Turn IF GAIN control fully clockwise.

b) With signal generator attenuator, adjust the signal until it is twice the height of the noise leve. This signal level should be no greater than -100dbm.

14. LOG SCALE ALIGNMENT 60DB

This alignment should be performed with the analyzer controls set as follows:

DISPLAY:	60DB Log
FINE TUNING:	Centered
SCAN WIDTH-CPS/CM:	1K
I.F. GAIN:	Nominal
FILTER:	Out
INPUT ATTENUATOR:	Out

a) With the DB shape potentiometer R61, set the screen Grid Voltage (Pin#6) of V8 (6AU6) for +22 volts.

b) Increase signal (500kHz) output of signal generator to provide full scale deflection (6cm).

c) Check the Log Steps (see Figure 6 - 5)

d) If log steps are out of spec, the DB Range potentiometer (R69) can be adjusted to compensate for error (after each adjustment use the Signal Generator Attenuator to maintain full scale deflection before checking log steps). (See Figure 6 - 5)

14. AMPLITUDE FLATNESS ALIGNMENT

Set analyzer controls as follows:

DISPLAY:	Linear
FINE TUNING:	Centered

FINE TUNING: Centered

FINE TUNING: Centered

SCAN WIDTH-CPS/CM:	10K
IF GAIN:	Centered
FILTER:	Out
INPUT ATTENUATOR:	Out

a) Set a 450kHz (supplied from the Signal Generator) input signal to the extreme right side of the graticule. Adjust the slug of L2, to peak this signal.

b) Set a 550kHz (supplied from the Signal Generator) input signal to the extreme left side of graticule. Adjust the slug of L1 to peak this signal.

c) Observe the amplitude of the 550kHz signal. Gradually turn the generator frequency down to 450kHz, observing the amplitude change as the signal moves from left to right on the graticule. The amplitude change should be no greater than 4db. If greater, than 4db, continue adjusting L1 and L2 for optimum flatness.

16. TUNING DIAL ALIGNMENT PROCEDURE

The tuning curve of the local oscillator is controlled by the shape of the plates in the tuning capacitor. This shape has been carefully controlled to ensure an optimum fit with the tuning dial. For these reasons, only the ends of the dial must be adjusted. The upper end frequencies are affected by the setting of trimmer capacitors C207, C208, C209 andC211. The lower end frequencies are set by the slugs in coils L201, L202, L203 and L204. Align each band as follows: (Scan Width-2kHz/cm and Lin Display).

a) With Band Switch set to the appropriate band, set tuning dial pointer to lowest frequency of the band. Provide a corresponding signal from generator. Adjust the coil slug of that band to center this frequency on the graticule.

b) On the same band set tuning dial pointer to the highest frequency. Provide a corresponding signal from generator. With the trimmer capacitor of that band, center this frequency on the graticule, The coil and trimmer of the same band interact to some degree. Therefore, it is necessary to repeat step (a) and (b) on

each band until the dial frequencies agree with the actual frequencies.

BAND	COIL	TRIMMER
1 (0.6 to 1.7 MHz)	L204	C211
2 (1.7 to 5.5 MHz)	L203	C209
3 (5.5 to 16 MHz)	L202	C208
4 (16 to 36 MHz)	L201	C207

NOTE: Be careful that the frequency set on the center graticule is the actual frequency and not the image. To distinguish the correct frequency, turn the generator frequency higher. If the signal moves to the left of the screen, this is the correct frequency. If it moves to the right it is the image.

17. MIXER BALANCE ALIGNMENT

The purpose of the adjustment is to minimize spurious response due to L.O. feedthru at 600kHz, on band 1. This is accomplished as follows:

a) Remove Input signal. Set SCAN WIDTH -CPS/CM to 2K and DISPLAY to LINEAR.

b) Set BAND switch to Band 1. Adjust TUNING until a spurious signal is visible in the vicinity of 600kHz.

c) Adjust Mixer Bal potentiometer (R6) to minimize the amplitude of this signal.

18. INPUT ATTENUATOR

a) Set the SCAN-WIDTH-CPS/CM to 2K and DISPLAY to Linear. Apply an RF Signal Within analyzer range and center this frequency on the screen. Switch INPUT ATTENUATORS -IN. Adjust the output of the Signal Generator to -20dbm. With IF GAIN control set a reference of this frequency on scale. Switch each INPUT ATTENUATOR-OUT and by substitution method, between the generator attenuator and the analyzer attenuator, measure the actual attenuation of each switch. The attenuation error shall be no greater than ±5%.

19. SENSITIVITY

To check Sensitivity set the analyzer controls as follows:

DISPLAY:	Linear
SCAN WIDTH-CPS/CM:	10K
IF GAIN:	Max
FILTER:	Out
INPUT ATTENUATOR:	Out

a) Apply an unmodulated RF Signal to any frequency within the range of the analyzer. Tune the analyzer to display the signal.

b) Turn signal generator output down to -100dbm. This signal should be visible above the display noise level.

20. VIDEO FILTER

50 milliseconds (nominal) video filter preset at factory. No alignment is needed.

21. INTERMODULATION DISTORTION CHECK

The level of IM produced by the analyzer can be determined by the following test:

Set the analyzer controls as follows:

DISPLAY:	60DB Log
IF GAIN:	Max (cw)
FILTER:	Out
scan width-CPS/CM:1	1K

a) Apply two full scale signals (5K apart) to the analyzer. Vary the frequency separation until IM products are visible on the skirts. All IM products should be 60db down, as shown in figure 6-6

VOLTAGE CHART

MODEL PSA 231

The voltages given in the following chart are given as a guide to normal performance. These voltages are typical and may vary slightly. Controls should be set as shown below:

SCAN WIDTH:	At 10K position

FINE TUNING	Center of Range
ATTENUATOR(INPUT)	Out
V POS	Centered
H POS	Centered
I.F. GAIN	Centered
WIDTH	Centered
DISPLAY:	A) Linear
	B) Video Filter Out
	C) Manual Scan
	D) Fast Scan-Out
MANUAL SCAN	Centered
BAND SWITCH	Band 1 (CCW)
TUNING	Centered

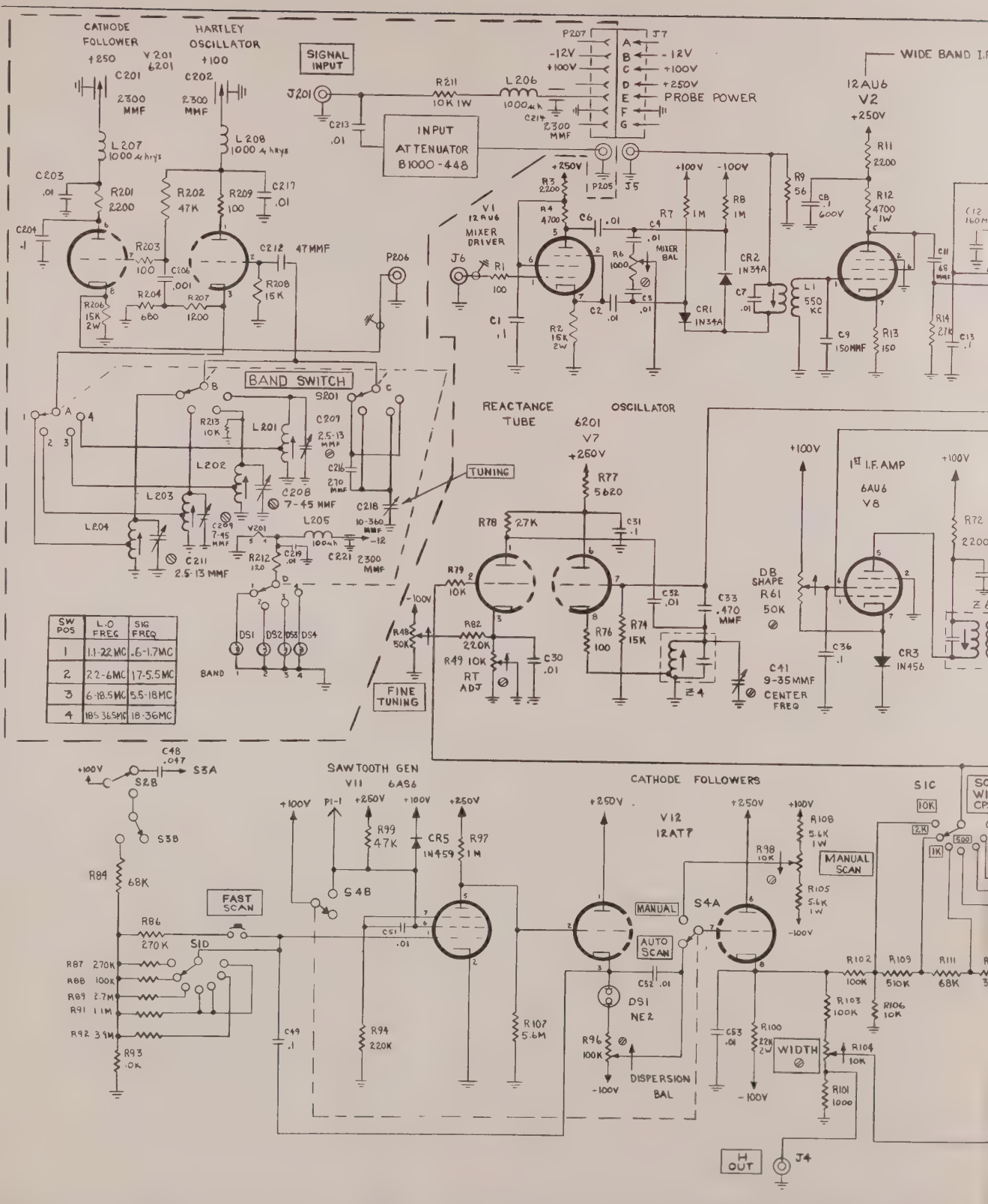
VOLTAGE CHART

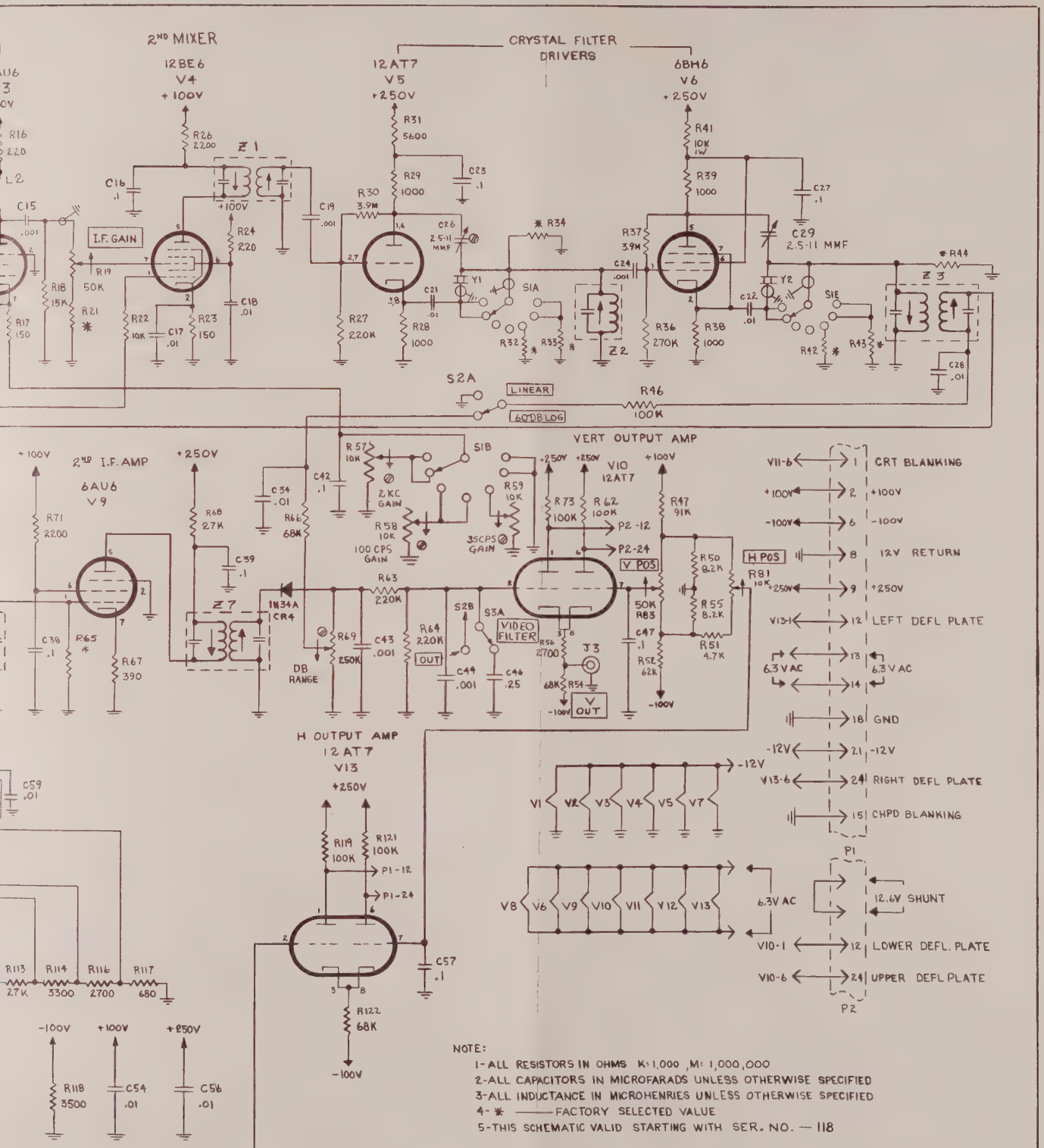
MODEL PSA 231

PIN NUMBERS

TUBE	1	2	3	4	5	6	7	8	9
V1 12AU6	98V	100V	0V	-12V	205V	225V	100V	-	-
V2 12AU6	0V	0V	0V	-12V	160V	160V	1.8V	-	-
V3 12AU6	0V	0V	0V	-12V	95V	95V	1.0V	-	-
V4 12BL6	-3.4V	1.5V	0V	-12V	91V	96V	0V	-	-
V5 12AT7	165V	6V	11V	0V	-12V	165V	6V	11V	-
V6 6 BN6	5.5V	9.3V	6.3V (AC)	0V	125V	132V	9.3V	-	-
V7 6201	175V	0V	3.2V	0V	-12V	200V	-0.55V	0.74V	0V
V8 6AU6	0V	0V	6.3V (AC)	0V	19V	4.4V	0.58V	-	-
V9 6AU6	0V	0V	6.3V (AC)	0V	220V	19V	0.38V	-	-
V10 12AT7	175V	-0.25V	5V	6.3V (AC)	6.3V (AC)	175V	1.4V	5V	0V
V11 6AS6	-1.2V	0V	0V	6.3V (AC)	3.3V	97V	-0.15V	-	-
V12 12AT7	250V	3.3V	8V	6.3V (AC)	6.3V (AC)	250V	-12V	-8.3V	0V
V13 12AT7	175V	-0.34V	5V	6.3V (AC)	6.3V (AC)	160V	1.4V	5V	0V
V201 6201	100V	-2.5V	0V	-12V	0V	230V	99V	100V	-6V

ALL VOLTAGES ON ABOVE CHART WERE MEASURED USING 20,000 OHM PER VOLT METER.


CATHODE FOLLOWER
+250
V201 6201
HARTLEY OSCILLATOR
+100
SIGNAL INPUT
J201
C201 2300 MMF
C202 2300 MMF
L207 1000 μ hrys
L208 1000 μ hrys
C203 .01
R201 2200
R202 47K
R209 100
C217 .01
C204 .1
R203 100
C205 .001
C212 47MMF
R208 15K
R206 15K 2W
R204 660
R207 1200
P206
R211 10K 1W
L206 1000 μh
C213 .01
C214 2300 MMF
INPUT ATTENUATOR B1000-448
P207
J7
-12V
+100V
+250V
PROBE POWER
P205
J5
WIDE BAND I.F.
12AU6 V2 +250V
R11 2200
R12 4700 1W
C11 68 MMF
C12 160MMF
R14 270
C13 .1
V1 12AU6 MIXER DRIVER
J6
R1 100
C1 .1
R3 2200
R4 4700
C6 .01
C4 .01
R7 1M
R8 1M
R6 1000
MIXER BAL
C3 .01
R2 15K 2W
C2 .01
CR1 IN34A
CR2 IN34A
C7 .01
L1 550 KC
C9 150MMF
R13 150
R9 56
C8 .1 600V
BAND SWITCH
S201
R213 10K
L201
C207 2.5-13 MMF
L202
C216 270 MMF
C208 7-45 MMF
L203
C218 10-360 MMF
L204
C209 7-45 MMF
C211 2.5-13 MMF
L205 100μh
C219 .01
C221 2300 MMF
R212 120
V201
-12
TUNING
REACTANCE TUBE
OSCILLATOR
6201 V7 +250V
R77 5620
R78 27K
C31 .1
R79 10K
C32 .01
C33 .470 MMF
R82 220K
R76 100
R74 15K
R49 10K RT ADJ
C30 .01
R48 50K
-100V
FINE TUNING
C41 9-35MMF CENTER FREQ
1ST I.F. AMP 6AU6 V8
+100V
DB SHAPE R61 50K
C36 .1
CR3 IN456
R72 2200
SW POS
L.O FREQ
SIG FREQ
1 1.1-22 MC .6-1.7 MC
2 2.2-6 MC 1.7-5.5 MC
3 6-18.5 MC 5.5-18 MC
4 18.5-36.5 MC 18-36 MC
BAND 1 2 3 4
DS1 DS2 DS3 DS4
C48 .047
S3A
S2B
S3B
R84 68K
FAST SCAN
R86 270K
S1D
R87 270K
R88 100K
R89 2.7M
R91 1.1M
R92 3.9M
R93 .01
C49 .1
SAWTOOTH GEN
V11 6AS6
+100V
P1-1
+250V
R99 47K
CR5 IN459
R97 1M
S4B
C51 .01
R94 220K
R107 5.6M
CATHODE FOLLOWERS
V12 12AT7
R98 10K
R108 5.6K 1W
R105 5.6K 1W
MANUAL SCAN
MANUAL
AUTO SCAN
S4A
C52 .01
DS1 NE2
R96 100K
DISPERSION BAL
C53 .01
R100 22K 2W
WIDTH
R104 10K
R101 1000
R102 100K
R109 510K
R111 68K
R103 100K
R106 10K
S1C
10K
2K
1K
500
H OUT
J4



NOTE:

1-ALL RESISTORS IN OHMS K=1,000 ,M= 1,000,000
2-ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED
3-ALL INDUCTANCE IN MICROHENRIES UNLESS OTHERWISE SPECIFIED
4- * ——— FACTORY SELECTED VALUE
5-THIS SCHEMATIC VALID STARTING WITH SER. NO. — 118

FROM SER#	DETAILS	BY	REV	FROM SER#	DETAILS	BY
			A	ALL	REC 253	
			B	122	REC 264 R65 ADDED	L Taub 12-1-66
			C	-	CORRECTED SCHEMATIC	-
			D	122	REC 310	L Taub 3-1-67

NELSON-ROSS ELECTRONICS, INC.
LONG ISLAND, NEW YORK

SCHEMATIC PSA231

D1000-648 REV D

PARTS LIST

MODEL PSA-231
MAIN CHASSIS

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R1	Resistor 100 ohms ½W 5%	IRC	Type GBT½
R2	Resistor 15K 2W 5%	IRC	Type GBT 2
R3	Resistor 2200 ohms ½W 5%	IRC	Type GBT½
R4	Resistor 4700 ohms ½W 5%	IRC	Type GBT½
R5	NOT USED		
R6	Resistor, Variable, 1K	Nelson-Ross	C1000-154-32
R7	Resistor 1 Meg ½W 5%	IRC	Type GBT½
R8	Same as R7		
R9	Resistor 56 ohms ½W 5%	IRC	Type GBT½
R10	NOT USED		
R11	Same as R3		
R12	Resistor 4700 ohms 1W 5%	IRC	Type GBT 1
R13	Resistor 150 ohms ½W 5%	IRC	Type GBT½
R14	Resistor 27K ½W 5%	IRC	Type GBT½
R15	NOT USED		
R16	Resistor 220 ohms ½W 5%	IRC	Type GBT½
R17	Same as R13		
R18	Resistor 15K ½W 5%	IRC	Type GBT½
R19	Resistor, Variable Dual, 50K	Nelson-Ross	C1000-154-3
R20	NOT USED		
R21	Chosen at Test		
R22	Resistor 10K ½W 5%	IRC	Type GBT½
R23	Same as R13		
R24	Same as R16		
R25	NOT USED		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R26	Same as R3		
R27	Resistor 220K ½W 5%	IRC	Type GBT½
R28	Resistor 1000 ohms ½W 5%	IRC	Type GBT½
R29	Same as R28		
R30	Resistor 3.9 Meg ½W 5%	IRC	Type GBT½
R31	Resistor 5600 ohms ½W 5%	IRC	Type GBT½
R32	Chosen at Test		
R33	Chosen at Test		
R34	Chosen at Test		
R35	NOT USED		
R36	Resistor 270K ½W 5%	IRC	Type GBT½
R37	Same as R30		
R38	Same as R28		
R39	Same as R28		
R40	NOT USED		
R41	Resistor 10K 1W 5%	IRC	Type GBT 1
R42	Chosen at Test		
R43	Chosen at Test		
R44	Chosen at Test		
R45	NOT USED		
R46	Resistor 100K ½W 5%	IRC	Type GBT½
R47	Resistor 91K ½W 5%	IRC	Type GBT½
R48	Resistor, Variable, 50K	Nelson-Ross	C1000-154-26
R49	Resistor, Variable, 10K	Nelson-Ross	C1000-154-2
R50	Resistor 8200 ohms ½W 5%	IRC	Type GBT½

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R51	Same as R4		
R52	Resistor 62K ½W 5%	IRC	Type GBT½
R53	NOT USED		
R54	Resistor 68K ½W 5%	IRC	Type GBT½
R55	Same as R50		
R56	Resistor 2700 ohms ½W 5%	IRC	Type GBT½
R57	Resistor, Variable, 10K	Nelson-Ross	C1000-154-10
R58	Same as R57		
R59	Same as R57		
R60	NOT USED		
R61	Resistor, Variable, 50K	Nelson-Ross	C1000-154-9
R62	Same as R46		
R63	Same as R27		
R64	Same as R27		
R65	Chosen at Test		
R66	Same as R54		
R67	Resistor 390 ohms ½W 5%	IRC	Type GBT½
R68	Same as R14		
R69	Resistor, Variable, 250K	Nelson-Ross	C1000-154-11
R70	NOT USED		
R71	Same as R3		
R72	Same as R3		
R73	NOT USED		
R74	Same as R18		
R75	NOT USED		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R76	Same as R1		
R77	Resistor, Film 5620 ohms ½W 1%	Dale	MFF½T1
R78	Resistor, Film 27K ½W 1%	Dale	MFF½T1
R79	Resistor, Film 10K ½W 1%	Dale	MFF½T1
R80	NOT USED		
R81	Same as R19		
R82	Resistor, Film 220K ½W 1%	Dale	MFF½T1
R83	Part of R81		
R84	Same as R54		
R85	NOT USED		
R86	Same as R36		
R87	Same as R36		
R88	Same as R46		
R89	Resistor 2.7 Meg ½W 5%	IRC	Type GBT½
R90	NOT USED		
R91	Resistor 1.1 Meg ½W 5%	IRC	Type GBT½
R92	Same as R30		
R93	Same as R22		
R94	Same as R27		
R95	NOT USED		
R96	Resistor, Variable, 100K	Nelson-Ross	C1000-154-8
R97	Same as R7		
R98	Same as R48		
R99	Resistor 47K ½W 5%	IRC	Type GBT½
R100	Resistor 22K ½W 5%	IRC	Type GBT½

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R101	Same as R28		
R102	Resistor, Film, 100K ½W 1%	Dale	MFF½T1
R103	Resistor, Film, 510K ½W 1%	Dale	MFF½T1
R104	Part of R19		
R105	Resistor 5600 ohms 1W 5%	IRC	Type GBT 1
R106	Same as R79		
R107	Resistor 5.6 Meg ½W 5%	IRC	Type GBT½
R108	Same as R105		
R109	Same as R103		
R110	NOT USED		
R111	Resistor, Film, 68K ½W 1%	Dale	MFF½T1
R112	Resistor, Film, 33K ½W 1%	Dale	MFF½T1
R113	Same as R78		
R114	Resistor, Film, 3300 ohms ½W 1%	Dale	MFF½T1
R115	NOT USED		
R116	Resistor, Film, 2700 ohms ½W 1%	Dale	MFF½T1
R117	Resistor, Film, 680 ohms ½W 1%	Dale	MFF½T1
R118	Resistor WW, 3500 ohms 5W 5%	Ward Leonard	5X3500
R119	Same as R46		
R120	NOT USED		
R121	Same as R46		
R122	Same as R54		
C1	Capacitor, Paper .1 MFD @600V	Aerovox	P829ZN28
C2	Capacitor, Ceramic Disc .01 MFD @ 600V	Centralab	DD6-103
C3	Same as C2		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
C4	Same as C2		
C5	NOT USED		
C6	Same as C2		
C7	Same as C2		
C8	Same as C1		
C9	Capacitor, Mica 150 MMF	MIL-C-5	CM15E151J
C10	NOT USED		
C11	Capacitor, Mica 68 MMF	MIL-C-5	CM15E680J
C12	Capacitor, Mica 160 MMF	MIL-C-5	CM15E161J
C13	Capacitor, Paper .1 MFD @ 200V	Amperex	C296AB/A100K
C14	Same as C2		
C15	Capacitor, Ceramic Disc .001 MFD @ 600V	Centralab	DD-102
C16	Same as C13		
C17	Same as C2		
C18	Same as C2		
C19	Same as C15		
C20	NOT USED		
C21	Same as C2		
C22	Same as C2		
C23	Same as C13		
C24	Same as C15		
C25	NOT USED		
C26	Capacitor, Variable 2.5-11 MMF	Erie	538-000-90R
C27	Same as C13		
C28	Same as C2		
C29	Same as C26		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
C30	Same as C2		
C31	Same as C13		
C32	Same as C2		
C33	Capacitor, Mica 470 MMF	MIL-C-5	CM15E471J
C34	Same as C2		
C35	NOT USED		
C36	Same as C13		
C37	Same as C13		
C38	Same as C13		
C39	Same as C13		
C40	NOT USED		
C41	Capacitor, Variable 9-35 MMF	Erie	538-000-94R
C42	Same as C13		
C43	Same as C15		
C44	Same as C15		
C45	NOT USED		
C46	Capacitor, Paper .25 MFD @ 200V	Aerovox	V161-440
C47	Same as C13		
C48	Capacitor, Paper .047 MFD @ 200V	Sprague	192P4739
C49	Same as C13		
C50	NOT USED		
C51	Same as C2		
C52	Same as C2		
C53	Same as C2		
C54	Same as C2		
C55	NOT USED		
C56	Same as C2		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
C57	Same as C13		
C58	NOT USED		
C59	Same as C2		
CR1	Diode	MIL-S-19500	IN34A
CR2	Same as CR1		
CR3	Diode	MIL-S-19500	IN456
CR4	Same as CR1		
CR5	Diode	MIL-S-19500	IN459
DS1	Neon Lamp	GE	NE-2
J1	NOT USED		
J2	NOT USED		
J3	Connector	MIL-C-3608	UG625B/U
J4	Same as J3		
J5	Same as J3		
J6	Same as J3		
J7	Connector	U.S.Components	M7S-LRN
L1	Coil	Nelson-Ross	A1000-247
L2	Coil	Nelson-Ross	A1000-110-2
P1	Connector	Amphenol	25-159-24
P2	Same as P1		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
S1	Switch, Rotary	Centralab	PA1017
S2	Switch Toggle	H.H.Smith	956
S3	Same as S2		
S4	Same as S2		
S5	Switch, Push Button	H.H.Smith	992
V1	Tube Electron	MIL-E-1	12AU6
V2	Same as V1		
V3	Same as V1		
V4	Tube Electron	MIL-E-1	12BE6
V5	Tube Electron	MIL-E-1	12AT7
V6	Tube Electron	MIL-E-1	6BH6
V7	Tube Electron	MIL-E-1	6201
V8	Tube Electron	MIL-E-1	6AU6A
V9	Same as V8		
V10	Same as V5		
V11	Tube Electron	MIL-E-1	6AS6
V12	Same as V5		
V13	Same as V5		
Y1	Crystal	Nelson-Ross	A1000-007-1
Y2	Paired with Y1		
Z1	Transformer	Nelson-Ross	A1000-009-1
Z2	Same as Z1		
Z3	Same as Z1		

PARTS LIST

MODEL PSA-231
Main Chassis

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
Z4	Transformer	Nelson-Ross	A1000-008-2A
Z5	Same as Z1		
Z6	Same as Z1		
Z7	Same as Z1		
	Socket, Crystal (2)	Augat	8000-AG2
	Socket, Tube, 7 pin (7)	Eby Co.	305-9727-50
	Socket, Tube, 9 pin (5)	Eby Co.	305-9713-26
	Socket, Tube, 7 pin (1)	MIL-S-12883	TS102P01
	Shield, Tube	MIL-S-12883	TS102V02
	Knob (1) - Scan width	Nelson-Ross	C1000-124-115
	Knob (2) - Fine Tuning; Manual scan	Nelson-Ross	C1000-124-6
	Knob (2) - IF Gain; V Pos	Nelson-Ross	C1000-124-3
	Lock, Panel (1)	Southco	43-99-124-41
	Handle, Panel (1)	Nelson-Ross	B1000-204

PARTS LIST

MODEL PSA-231
OSCILLATOR

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
R201	Resistor 2200 ohms ½W 5%	IRC	Type GBT½
R202	Resistor 47K ½W 5%	IRC	Type GBT½
R203	Resistor 100 ohms ½W 5%	IRC	Type GBT½
R204	Resistor 680 ohms ½W 5%	IRC	Type GBT½
R205	NOT USED		
R206	Resistor 15K 2W 5%	IRC	Type GBT 2
R207	Resistor 1200 ohms ½W 5%	IRC	Type GBT½
R208	Resistor 15K ½W 5%	IRC	Type GBT½
R209	Same as R203		
R210	NOT USED		
R211	Resistor 10K 1W 5%	IRC	Type GBT 1
R212	Resistor 120 ohms ½W 5%	IRC	Type GBT½
R213	Resistor 10K ½W 5%	IRC	Type GBT½
C201	Capacitor 2300 MMF	Centralab	FT 2300
C202	Same as C201		
C203	Capacitor, Ceramic Disc .01 MFD @ 600V	Centralab	DD6-103
C204	Capacitor, Paper .1 MFD @ 200V	Amperex	C296AB/A100K
C205	NOT USED		
C206	Capacitor, Ceramic Disc .001 MFD @ 600V	Centralab	DD-102
C207	Capacitor, Variable 2.5-13pt	Centralab	822 BZ
C208	Capacitor, Variable 7-45 pf	Centralab	822 BN
C209	Same as C208		
C210	NOT USED		
C211	Same as C207		

PARTS LIST

MODEL PSA-231
Oscillator

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
C212	Capacitor, Mica 47 MMF	MIL-C-5	CM15E470J
C213	Same as C203		
C214	Same as C201		
C215	NOT USED		
C216	Capacitor, Mica 270 MMF	MIL-C-5	CM15E271J
C217	Same as C203		
C218	Capacitor, Variable 10-360 MMF	Miller	2111
C219	Same as C203		
C220	NOT USED		
C221	Same as C201		
DS201	Lamp	Transistor Electronics Corp.	SDL-BBB1-680
DS202	Same as DS201		
DS203	Same as DS201		
DS204	Same as DS201		
L201	Coil, Variable	Nelson-Ross	A1000-094-4
L202	Coil, Variable	Nelson-Ross	A1000-094-3
L203	Coil, Variable	Nelson-Ross	A1000-094-2
L204	Coil, Variable	Nelson-Ross	A1000-094-1
L205	Coil, RF 100 uhy	National	R1550-37
L206	Coil, RF 1000 uhy	Delevan	2500-28
L207	Same as L206		
L208	Same as L206		

PARTS LIST

MODEL PSA-231
Oscillator

ITEM	DESCRIPTION	MFR.	MFR. PART NO.
P207	Connector	U.S.Components	M7P-LS-H19C
S201	Switch, Rotary	Centralab	PA2010
V201	Electron Tube	MIL-E-1	6201
	INPUT ATTENUATOR	Nelson-Ross	B1000-448-6
	CABLE ASSEMBLY	Nelson-Ross	C1000-593-12
	CABLE ASSEMBLY	Nelson-Ross	C1000-593-13
	CABLE ASSEMBLY	Nelson-Ross	C1000-593-18
	Socket, Tube, 9 pin (1)	MIL-S-12883	TS103P01
	Shield, Tube, 9 pin (1)	MIL-S-12883	TS103V02
	Drive Unit (1)	Jackson Bros.	4511/DRF
	Pulley Drive (1)	Nelson-Ross	A1001-042
	Pulley Drive (3)	General Cement	6057GC
	Dial Drum (1)	Jackson Bros.	4030
	Spring (1)	General Cement	6452C
	Pointer Block (1)	Nelson-Ross	A1000-086
	Dial Cord	Walsco	664-02
	Knob (2) - Band Switch; Tuning	Nelson-Ross	C1000-124-11
	Knob (1) - Panel Lock	Nelson-Ross	B1000-181-1

P 1
PROBE

MODEL P1 HIGH IMPEDANCE PROBE

PURPOSE

The input impedance of the NELSON-ROSS plug-in Spectrum Analyzer is 50 ohms. This low impedance may not be tolerable when high output impedance devices such as video amplifiers etc., are being measured.

The 1 Meg ohm input impedance of the NELSON-ROSS Model P1 probe will provide the required isolation between the equipments, to enable the user to make accurate measurements.

DESCRIPTION

The probe consists of a field effect transistor, connected as a voltage follower to provide high input impedance. This is followed by a NPN Silicon transistor emitter follower which provides a 50 ohm output impedance. Both DC power and RF output are fed down the single coaxial cable and are separated by networks at the cable ends.

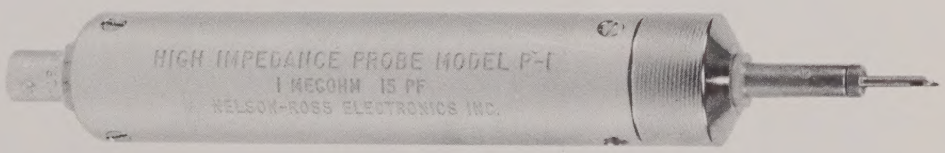
OPERATING INSTRUCTIONS

When the NELSON-ROSS Model P1 probe is to be used for measurements, proceed as follows:

A. Connect the P1 probe to the Input connector on the Plug-In.
B. Pull the "PULL FOR PROBE" switch out.
C. You are now ready to make measurement with the High Impedance probe.
D. When the probe is not to be used be sure to push the "PULL FOR PROBE" Switch In. This is important since a DC voltage is connected to the signal lead when the switch is Out.

P1 PROBE SPECIFICATIONS

INPUT IMPEDANCE	1 Meg
INPUT CAPACITANCE	10 to 15 mmf

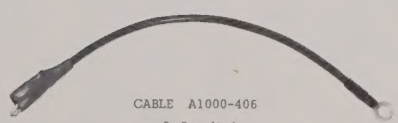


CABLE A1000-403-1
1 Supplied

CLIP GC 33-334
2 Supplied

PLUG GC 33-058
2 Supplied

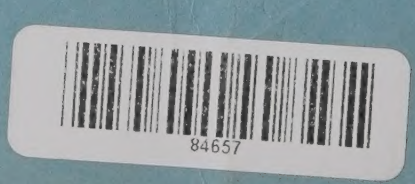
CLIP GC 33-164
2 Supplied



CABLE A1000-406
2 Supplied

WARRANTY

NELSON-ROSS ELECTRONICS, INC. WARRANTS EACH INSTRUMENT MANUFACTURED BY THEM TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP. OUR LIABILITY UNDER THIS WARRANTY IS LIMITED TO SERVICING OR ADJUSTING ANY INSTRUMENT RETURNED FOR THAT PURPOSE AND TO THE REPLACEMENT OF ANY DEFECTIVE PARTS THEREOF. THIS WARRANTY DOES NOT COVER FUSES, BATTERIES AND TUBES. THIS WARRANTY IS EFFECTIVE FOR ONE YEAR AFTER DELIVERY TO THE ORIGINAL PURCHASER, WHEN THE INSTRUMENT IS RETURNED, TRANSPORTATION PREPAID, AND WHEN OUR EXAMINATION PROVES TO OUR SATISFACTION THAT THE INSTRUMENT IS DEFECTIVE. DEFECTS DUE TO ABUSE, MISUSE OR ABNORMAL CONDITIONS OF OPERATIONS WILL BE REPAIRED AT COST, ON APPROVAL OF ESTIMATE.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